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For: Method and System for Processing Carrier Materials by Heavy Ion Irradiation and Subsequent Etching

Translation of Claims Filed in Response to Action under Rule 66 PCT

1. A method of processing carrier material by heavy ion irradiation and subsequent etching process for generating recesses leading from the surface of the carrier material into the interior of the carrier material, the heavy ion irradiation being carried out such that the influx of a bundle of rays (1) of high-energy heavy ions (1.1) onto a carrier surface (2) takes place under at least two different angles, characterized by the fact that by controlling the irradiation, especially by the parameters

- applied irradiation density of the heavy ions;
- influx angle of the heavy ion beams (1.1) onto a carrier surface (2);
- angle of the different influx directions of the heavy ion beams against each other;
- range of the radiation in the solids body; and
- energy dissipation per unit of length along the trajectories of the high-energy heavy ions penetrating into the solids body

and the subsequent etching process as large a number of common intersections are generated each of which connects two recesses with each other to an united volume unit and the intersections of which are to be found in areas of the recesses in the interior thereof, i.e. within the area of the solids body and as far away as possible from the area of the carrier material near its surface, and that the result of the subsequent etching process is recesses of an aspect ration A, i.e. the ratio of the length relative to the average radial

extent of the recesses (4), from $A \geq 3$, if possible $A \approx 4$.

2. The method of claim 1, characterized by the fact that collimation and blocking of heavy ion beams (1.1) are combined for generating as large a number of common intersections (4) in foils (2) as carrier material by repeatedly passing the foils (2) below an irradiation mask (5), the ion beams (1.1) in every passing of the foils impinging upon the foil, i.e. the carrier material, at a bombardment angle $\pm\alpha$ or $+\alpha_1 / -\alpha_2$.

3. The method of claim 1 or 2, characterized by the fact that the heavy ions (1.1) do not permeate the foils, i.e. the carrier material (2).

4. The method of one of claims 1 to 3, that the heavy ion irradiation and the subsequent etching result in undercut recesses (4) which to the extent possible are of frusto-conical shapes, cavities.

5. The method of one of claims 1 to 4, characterized by the fact that the result of the etching process recesses (4) of a basic geometric shape of lobes and similar shapes at a constant aspect ratio $A \geq 3$ are formed to an ion trace foil which depending upon the conditions of irradiation form a surface-depth-relief with as large as possible a number of recesses with common intersections and thus, following the subsequent coating process, form a stable and lasting anchoring of the applied cover layer in the ion trace foil in the united volume units consisting of recesses with common intersections, formed tie-ins and additionally etched-out undercuts in the surface of the carrier material.

5. The method of one of claims 1 to 5, characterized by the fact that as a result of the selected processing steps during irradiation and etching, the surface-depth-relief of the carrier foil (2) has a fractal structure of the fractal dimension D of $2<d<3$, the etching conditions having to be selected such that a large number of recesses (4) with common intersections and an aspect ratio

of the recesses (4) $A \geq 3$ is maintained.

7. An system for processing carrier material by heavy ion irradiation, the source of radiation used being a heavy ion accelerator, i.e. a linear accelerator (e.g. RFQ-accelerator) or circular accelerator (e.g. cyclotron), wherein an partial portion of the ion rays (1.1) may be blocked by a diaphragm (11) arranged between the source of radiation and the carrier material (2) and the ion rays (1.1) after passing the diaphragm (11) impinging upon the surface of the carrier material (2) to be processed, characterized by the fact that a deceleration module (13) is arranged between the source of radiation and the diaphragm (11), the aimed bundle of rays penetrating into the carrier material at a defined influx energy depending upon the adjustment of the thickness of the deceleration module thus providing a defined range and energy dissipation of the penetrating heavy ions.

8. The system of claim 7, characterized by the fact that in case the carrier material is a foil strip, there is provided a symmetrically or asymmetrically constructed roller system for transport of the foil, the arrangement being constructed as follows:

a) a source of radiation;

b) a deceleration module (13), arranged as seen in the direction of heavy ion beam (1.1) propagation in front of the diaphragm (11) and in front of the roller system (8,9,10) and thus in front of the foil strip, i.e. the carrier material (2), running thereon;

c) a feed roller (6) for the still unprocessed foil strip, i.e. carrier material (2), at the beginning of the processing path;

d) a take-up roller (7) for the irradiated foil strip, i.e. the carrier material (2), at the end of the processing path;

e) a deflection roller (9) adjustably arranged on a rail (12) arranged in parallel and vertically to the bundle of rays of heavy ions (1); and

f) two fixing rollers (8,10) respectively arranged between the feed

roller (6) and deflection roller (9) and deflection roller (9) and the take-up roller (7), the fixing rollers (8,10) and the feed roller (6) as well as the take-up roller (7) not lying in a common plane.

9. The system of one of claims 7 or 8, characterized by the fact that the deceleration module (13) consists of foils and that the deceleration module (13) over its longitudinal extent is provided with foils of different thicknesses in order for each influx angle $+\alpha_1$ or $-\alpha_2$ to ensure a desired influx value of the ions penetrating into the carrier material (2).